

## **HOT-START SOLENOID VALVE**

### **INVENTORS**

10

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### **FIELD OF THE INVENTION**

This invention relates generally to Engine Management and, more specifically, to carburetion controls.

### **BACKGROUND OF THE INVENTION**

15 There are two current mechanisms used for hot-start valve manipulation: a cable and housing or cable operated systems used for manipulating a carburetor body-mounted valve or a manually manipulated carburetor body-mounted valve assembly 10a as is shown in FIGURE 1a. The manually manipulated carburetor-mounted valve needle 18 requires the rider to take one hand off the handlebars and reach down to the valve location, grasp the  
20 valve handle 12 on the carburetor 30 to withdraw the valve needle 18 to admit atmospheric air 21. The act of manipulation is necessary whenever a restart is required or desired when the engine assembly is at operating temperatures or hot-start conditions. The act of removing the rider's hand from the handlebars and looking at the carburetor 30 in order to locate and manipulate the valve is time consuming and can be difficult during racing when rapid restarts

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are desired. These movements must be reversed to again replace the valve needle 18 under running conditions.

Cable-operated systems 10b allow for a handlebar located pull for remote activation and are an improvement over the carburetor-mounted valve as shown in FIGURE 1a. This 5 system uses a cable 13, connected to a lever that is mounted to a handlebar-mounted clamp, usually the backside of a brake clamp or incorporated into a clutch mount. Clamping along a frame of a motorcycle fixedly holds a housing 14 for the cable 13. The movement of the cable 13 within and relative to the housing 14 results in a precise movement used to open and close the valve needle 18. Free play adjustment is required to ensure proper valve needle 18 10 positioning in the carburetor body 30. This adjustment ensures that the valve needle 18 is not held out of its position in the carburetor body 30, effectively activating the hot-start system and introducing air 21 into the intake passage during normal operating conditions. It also ensures that when the lever is pushed, the cable 13 is sufficiently withdrawn as to provide adequate removal of the valve needle 18 from the carburetor body allowing the additional air 15 into the intake passage that facilitates starting. Because of the necessity of regular adjustment to optimize the operation, cable operation is not adequate for a robust system.

What is needed in the art is a system that does not require adjustment. Additionally, there is an unmet need for a means of activation would allow for accurate sensing of the need for activation of a hot-start valve and would automatically activate or automatically allow 20 activation of the valve. Additionally, an electrical system allows selective locking-out of the activation of the valve.

#### **SUMMARY OF THE INVENTION**

A solenoid-operated plunger valve controls airflow from the external environment to the air fuel mixture of the carburetor for an internal combustion engine. During normal 25 operation, the valve plunger extends into the carburetor body, blocking the air passage used for introduction of additional air into the intake passage. During restarts at operating

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temperatures, the normally open switch is closed by the operator's thumb at the handlebar when hot engine conditions require additional air into the intake passage. Closing the switch allows electrical current stored in the battery to energize the solenoid, removing the plunger from the carburetor body and introducing additional air into the intake passage. In another 5 preferred embodiment, there is a toggle switch that allows for "hands free" operation of the hot-start valve during race conditions. The toggle switches the hot-start system between manual (push button) activation and thermal switch activation with a time-out circuit. The time-out circuit allows for a predetermined amount of time to pass with the hot start activated while the engine is not running and above a set operating temp. This further reduces the need 10 to visually locate a hot-start activation switch when quick restarts are necessitated by engine stalls during competition.

The preferred embodiment of the invention includes a hot-start mechanism for an internal combustion engine carburetor having an airflow passageway. The mechanism includes a valve, an electrically-operated valve-movement mechanism, and a valve switch. 15 The valve is in fluid communication with the airflow passageway. The valve-movement mechanism is operatively connected to the valve to selectively move the valve. Activation of the valve-movement mechanism opens the valve to admit additional air into the airflow passageway. The valve switch is electrically coupled to the valve-movement mechanism for activation of the valve.

20 In one preferred embodiment, the invention includes a processor electrically coupled to the switch. A processor controls the valve and a power source is electrically coupled to the processor. The power source is preferably a battery. A solar collector is coupled to the battery to keep it charged in one embodiment.

25 A preferred embodiment of the valve-movement mechanism includes a solenoid. In such embodiment, the valve is more specifically a plunger valve.



One preferred aspect of the invention includes a temperature sensor interconnected with the processor. The temperature sensor provides a signal indicative of the engine temperature. The processor only activates the solenoid to open the valve when the engine temperatures are within a predetermined range.

5 Another preferred aspect of the invention includes an engine-running sensor interconnected with the processor. The engine-running sensor provides a signal to the processor indicative of whether the engine is running. The solenoid holds the valve closed upon an engine-running condition or a running condition at a certain RPM level. The engine-running sensor preferably includes a connection to an engine stator to magnetically sense the  
10 dynamic rotational state of the engine. Where both an engine-running sensor and a temperature sensor are employed, the processor opens the valve upon predetermined input from the sensors.

In one preferred embodiment, a timer switch for closing the valve after a predetermined time lapse is provided. An indicator light is also provided to signal to the user  
15 whether the valve is open. In one embodiment, an override switch is interconnected with the valve-movement mechanism to control the position of the valve regardless of input from the sensors.

In one embodiment where the engine includes a start switch, the valve switch is coupled to such start switch for opening of the valve if the engine temperatures are within a  
20 predetermined range and the start switch is activated.

The present invention also includes a method of starting a carbureted engine. The method includes the steps of determining the need for additional air entrainment into the carburetor, electrically opening an air-entrainment valve allowing additional air into the carburetor, cranking the engine until a running state is achieved, and closing the valve. In the  
25 preferred embodiments, a plunger valve is employed. The step of opening the valve is carried out with a solenoid coupled to the plunger valve. Engine temperature is sensed as

part of the step of determining the need for additional air entrainment. Oxygen sensors and other engine state sensors such as manifold air pressure are advantageously used to sense the engine state while not adding significantly to the cost. Sensing the running state of the engine also comprises part of such step. Preferably, a timeout switch is employed to close 5 the valve after it is opened. Furthermore, a vehicle start switch is used in one embodiment to open the air-entrainment valve after the step of determining the need for additional air entrainment.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

The preferred and alternative embodiments of the present invention are described in 10 detail below with reference to the following drawings.

- FIGURE 1a is a side view of a prior-art manual plunger valve;
- FIGURE 1b is a system schematic of the prior-art manual plunger valve;
- FIGURE 2a is a side view of a prior-art engine assembly with a cable operated plunger valve installed;
- 15 FIGURE 2b is a system schematic of the prior-art engine assembly with a manual cable-controlled plunger valve installed;
- FIGURE 3a is a side view of an engine assembly with a solenoid-controlled plunger valve installed;
- 20 FIGURE 3b is a system schematic of the engine assembly with a solenoid-controlled plunger valve installed;
- FIGURE 4 is a system schematic of the engine assembly with a solenoid-controlled plunger valve installed;
- FIGURE 5 is an alternate system schematic of the engine assembly with a solenoid-controlled plunger valve installed; and
- 25 FIGURE 6 is a flowchart of the method for a hot start of an engine using a solenoid-controlled plunger valve.

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## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGURE 1a is a diagram showing a prior-art carburetor-mounted valve. This type of valve mounts directly to a carburetor body, which is located in the engine area near the rider's knee when in the riding position. The operative elements of the prior-art valve 5 include a handle 12 attached to a shaft 16 passing through a retaining nut 17 and affixed to a valve needle 18. A spring 11 urges the needle 18 into a seat on a carburetor body 30. An operator pulls the handle axially away from the retaining nut 14 thereby admitting air 21 into the carburetor bore 32 through the seat (not shown).

As illustrated in FIGURE 1b, the plunger valve assembly 10 is incorporated onto a 10 motorcycle internal combustion engine assembly 50 by installation into the carburetor body 56. Placement of the plunger valve assembly 10a requires the rider to remove a hand from handlebars to manipulate the plunger handle 12 during hot-start conditions. The plunger valve assembly 10 must be manipulated at its location on the carburetor throat 56, located near the rider's knee, while the rider is in the seated position, sitting on the 15 motorcycle, in order to restart the engine 50.

Also shown is the air filter 52 in the airflow 54 into the engine 50. The carburetor body 30 are portrayed as is a stator 24 on an engine shaft.

Referring to FIGURES 2a and 2b, as with the manual system portrayed in FIGURES 1a and 1b, the plunger valve assembly 10 is incorporated onto a motorcycle 20 internal combustion engine assembly 50 by installation into the carburetor throat 56. The cable system allows remote activation of the plunger valve assembly 10 and no longer requires the rider to remove hand from handlebars to manipulate the plunger handle 12 (Figure 1a) during hot-start conditions. Cable systems allow remote location of the activation lever 65 near the rider's hand on the handlebars 60, but do require incorporation 25 into the clutch or brake mounting hardware. A cable 13 and housing assembly 14 replaces the lever 12 and connects to the plunger valve assembly 10 on a first end and to the activation handle 67, fastened by a clamp 65 mounted on a handlebar. The use of the cable 13 and

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housing 14 requires lever 12 free play adjustment and associated cable 13 and housing 14 maintenance.

Also shown is the air filter 52 in the airflow 54 into the engine 50. The carburetor body is portrayed as is a stator 24 on an engine shaft.

5 Differing from the system portrayed in FIGURES 1a and 1b and the system portrayed in FIGURES 2a and 2b, the plunger valve assembly 10c of the present invention portrayed in FIGURES 3a and 3b is motivated by a solenoid 15 to allow electrical opening and closing of the needle valve 18.

In its simplest form, the invention is a solenoid actuator 15 for a hot start valve 10 assembly 10c. Still present are the mounting nut 17, the valve needle 18 selectively admitting the atmospheric air 21 into the carburetor bore 32. A spring 10 optionally urges the valve needle 18 into a seat sealing the valve in opposition to the pull of the actuated solenoid 15. A pair of leads 23 selectively conducts a current to activate the solenoid 15.

15 Principal elements of the solenoid plunger valve assembly 10 are shown in FIGURE 4. The valve needle 18 is attached to a shaft 16 passing through a retaining nut 17. Rather than using a handle 12 (FIGURE 1), a solenoid coil draws the shaft 16 which, in turn, draws the needle 18 away from the seat in the carburetor body (not shown). Wire connections 255 and 256 selectively energize the solenoid 15.

A presently preferred embodiment is shown in FIGURE 4. A processor 20 is 20 electrically interposed between the battery 216 and the plunger valve assembly 10 with wire connections 221 through 264. Specifically, the battery is connected by a positive wire connection 264 and a negative 260 or conventionally a ground wire connection. By two further wire connections 252 and 256, the processor 20 is connected to selectively operate the plunger valve assembly 10. The processor is also connected by two wire connections 244 25 and 248 to a stator 24 in magnetic proximity to an engine shaft for the purpose of indicating to the processor 20 the rotational state of the engine shaft thereby allowing the processor 20



to ascertain whether the engine is running. Still another pair of wire connections 236 and 240 connect a thermal sensor 28 to the processor 20 to indicate the temperature of the engine assembly 50.

5        Optionally a solar collector 265 is provided to charge the battery, ideally through a connection in the processor 20. In this embodiment, where a battery is used, charging the battery does not increase the load on the engine. The solar collector 265 is preferably a solar panel secured externally to the vehicle. A flexible panel may be used, for instance secured to the top of the fuel tank. A rigid panel may alternatively be used, mounted to the vehicle in an out-of-the-way location. Indeed, the solar panel might advantageously be placed on a helmet 10      of a rider conducting a charging current through a suitable set of leads to the battery 216.

Another embodiment allows the substitution of a capacitor for the battery 216. Charging and discharging a capacitor to activate a solenoid 15 is advantageously used to form a no-maintenance package for such vehicles as may not require a more complex electrical system. In such a system, a current is generated by a rotor spinning with the engine 15      shaft past the stator 24. Pressing a switch 64 activates the solenoid 15 by discharging the capacitor.

According to the presently preferred embodiment, the processor senses the temperature by means of the thermal sensor 28, whether the engine is running by virtue of the stator 24. Where the engine assembly 50 is suitably hot to require a hot-start strategy, 20      when requested, the processor 20, admits current from the battery 216 to the valve assembly 10 admitting air to the carburetor body 56 as the starter (not pictured) turns the engine over.

The requesting mechanism in the presently preferred embodiment comprises the remaining four wire connections 221, 224, 228, and 232. Wire connections 221 and 224 25      connect to a switch 64 to request a hot-start activation of the plunger valve assembly.

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An indicator light 68 shows the activation state of the switch 64. Both the indicator light 68 and the switch 64 are mounted on the handlebar 60 and communicate with the remainder of the system by means of a wire bundle 27. Activation of the switch 64 is received at the processor 20 as a request for hot-start activation of the plunger valve assembly 10. Additionally, a lock out switch 62, also mounted on the handlebar, allows the operator to lock out any request to activate the plunger valve assembly 10 where the operator's judgment suggests that overriding the processor 20 is appropriate.

Referring to FIGURES 5, 4, 3a and 3b, one embodiment of the invention includes a readily controllable interface between the rider and the invention. To further an object of the invention, the interface includes a switch 64 including a three-way activation system. The switch 64, in this embodiment, has a single push button normally open switch that the rider will depress to activate the solenoid 15. The single push button may also be moved from a position 42a to a position 42b to selectively enable an automatic feature of the invention. In the automatic mode, the timer circuits 20 will suitably and selectively activate the solenoid 15 to withdraw the valve needle 18 to allow hot starts. The position of the switch is conveyed by means of the wire bundle 27.

Advantageously, an LED 44 is included to indicate the interface state. Dual colored LEDs 44 might be used or a single colored LED 44. The purpose of the LED 44 is to allow the rider to be aware of the recognized state of the timer circuit. Such an LED 44 would advantageously serve as a troubleshooting enunciator for service of the system. In another embodiment, the LED 44 could signal the state of the valve rather than the state of the timer circuit. Another embodiment might include both LEDs.

FIGURE 6 is a flowchart of the method for a hot start of an engine using a solenoid-controlled plunger valve. The method begins with sensing the engine state to determine if it is running and its temperature. The process proceeds to element 74, a determination of the hot-start engine state. If the engine is in a hot-start, non-running engine state, the solenoid is



energized to admit additional air into the carburetor. If it is not in a hot-start engine state then the solenoid is not activated and the engine is simply started without opening the valve with the solenoid. Under the hot-start state, once the solenoid is opened the engine is turned over. Once the engine is turned a check is made to see if the engine has started at which 5 point the solenoid would be de-energized such that the valve is closed.

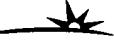
While the preferred embodiment of the invention has been illustrated and described, as noted above, many changes can be made without departing from the spirit and scope of the invention. For example, the system might further sense atmospheric pressure and compare it to manifold pressure for appropriate activation. Accordingly, the scope of the invention is 10 not limited by the disclosure of the preferred embodiment.

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